Excretion of Purine Derivatives by Dairy Cows Abomasally Infused With Incremental Amounts of Purines

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Introduction

Standard in vivo methods of estimating ruminal microbial protein supply require using exogenous markers (e.g., ^{15}N-ammonium salts) and animals that are cannulated in the abomasum or small intestine. Cannulations of this type are undesirable from an animal health standpoint; furthermore, estimation of microbial protein flow using markers and animals cannulated in the lower tract is laborious and imprecise. Topps and Elliott (1965) reported a correlation between urinary allantoin excretion and purine concentration in the rumen of sheep, suggesting the utility of allantoin excretion as an index of ruminal microbial protein flow. Subsequently, quantitative relationships between urinary purine derivative (PD) excretion and purine flow rates have been reported in sheep and cattle maintained by total intragastric nutrition. Because extrapolation of these data to lactating dairy cows seemed dubious, we determined the relationship between intestinal purine flow and urinary PD excretion using Holstein cows, maintained in a normal nutritional state, with body weight and purine flows approximating that of lactating cows.

Materials And Methods

Five ruminally cannulated Holstein cows (two lactating, three dry) were fed a diet consisting of corn silage (37.5% DM) plus dicalcium phosphate (190 g/d). Cows had free access to water and trace-mineralized salt blocks throughout the trial. Lactating cows were milked twice daily and were dried off immediately following completion of period 5. Purines were infused at five equally spaced levels as brewers yeast (Labudde Feed Co., Grafton, WI) during five experimental periods (P2 to P6) according to a Latin square design. Purine flow arising from the normal ruminal microbial population was determined in all cows during the two periods immediately preceding (P1) and following (P7) the infusion periods, as well as in each cow receiving 0 g/d purines during the infusion periods (i.e., P2 to P6). All experimental periods were 7 d in length. Suspensions of brewers yeast were continually mixed on magnetic stirrers and infused, using a multi-channel peristaltic pump, via tubing passed through the rumen cannula, through the rumen and omasum, and into the abomasum. Infusions were initiated at 1800 h on d 3 of each experimental period and maintained for 96 h. Total urine collections were made using indwelling Foley catheters which were inserted 24 h following initiation of infusions and daily urine output was measured for three days. Fresh containers with 500 ml of 1.5 N H_2SO_4 were attached to each cow at 0700 and 1800 h of each d. Purine derivatives (allantoin plus uric acid) were determined in milk and urine samples and creatinine was determined in urine samples.

Results and Discussion

The relationship between total PD excretion (mmol/d) and purine flow (mmol/d) was described by the equation:

$$\text{PD excretion} = .856 \times \text{purine flow} + 103 \quad (r^2 = .93) \quad (1)$$

In addition to total PD excretion, both allantoin excretion ($r^2 = .94$) and the urinary allantoin:creatinine ratio ($r^2 = .88$) were highly correlated with purine flow (Fig. 1). By measuring the microbial crude protein (MCP) to purine ratio of ruminal microorganisms and rearranging Eqn. 1, MCP flow can be estimated from PD excretion using the equation:

$$\text{MCP, g / d} = \frac{\text{g MCP}}{\text{mmol purine}} \times \frac{\text{mmol /d PD excretion - 130}}{.856} \quad (2)$$

Conclusion

Purine derivative excretion responded linearly to abomasal purine infusions in Holstein cows. Combined with a measurement of the CP to purine ratio in ruminal microbes, measurement of PD excretion offers promise as a useful method to estimate microbial crude protein supply in vivo.

Reference

Topps, J.H. and R.C. Elliott. 1965. Relationships between concentrations of ruminal nucleic acid and excretion of purine derivatives by sheep. Nature 205:498-500.

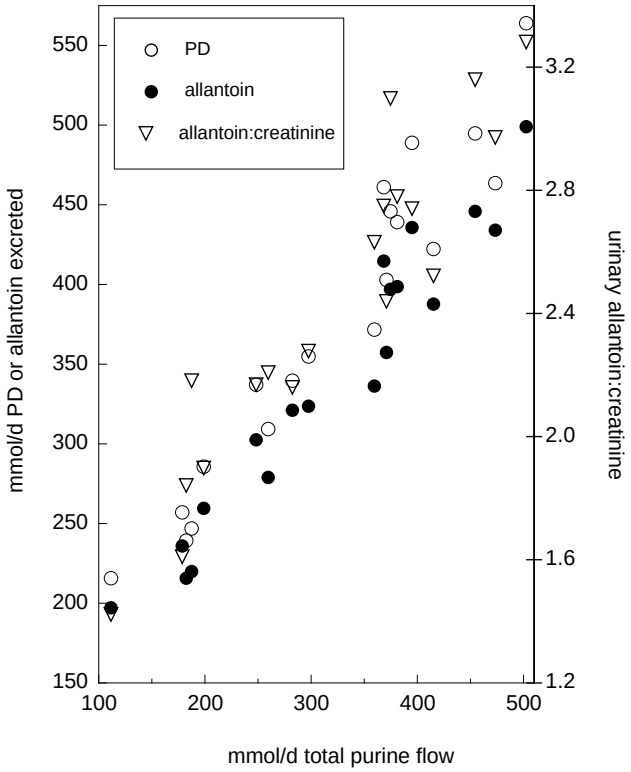

Figure 1. Relationship of total purine derivative (PD) excretion, allantoin excretion, and urinary allantoin:creatinine ratio with abomasal purine flow.